Quarterly Progress Report

Grant #7310006

Arctic Thermal Shutters and Doors

Arctic Sun, LLC

July 1, 2013 through October 11, 2013

Deliverables Submitted: The completed data collection plans and drawings for the testing box and project instrumentation were submitted and approved.

Budget: No invoices were submitted for reimbursement since the last quarterly report. An $11,000 advance payment request was submitted on August 19 and approved. Attached is a reimbursement form with back-up for all of the expenditures from July 1 through October 11, totaling $18,079.94. The majority of the expenses were for labor and materials to build the test box and install the data collection equipment. All of these expenses are summarized on the attached Excel spreadsheet titled "3rd Qtr Grant report 2013." Since inception, $45,000 has been advanced and $51,149.31 has been expended.

Schedule Status: Throughout this quarter, Arctic Sun continued to be busy with the peak of our business's installation season, and consequently, we are still a bit behind schedule with the finalization of the blown-in shutter design. We should be able to make up progress now that other field work has slowed. Staff is currently in town and can focus more time on this grant project. We don't anticipate this will hinder our ability to complete the primary project objectives within the term of the grant.

Percent Complete:

Task	Start Date	End Date	Deliverables	Percent Complete
Complete ridged shutter and door design	Jan 2013	April 2013	Design Plans	100%
Complete Blown-in shutter design	Jan 2013	May 2013	Design Plans	95%
Develop plans for testing box and project instrumentation	Jan 2013	May 2013	Testing box design and performance monitoring plans	100%
Construct testing box	March 2013	May 2013		90%

Work Progress:

Task 1. Ridged shutter and door design; The final designs were approved.

Task 2. Blown-in shutter design; We are continuing to perform the UV stability test on the EPS beads as described in the last report. The test window-box that was placed outside on June 28th is still in place and receiving significant solar exposure with no visible effect to the beads inside. We will open the container soon and perform a detailed physical examination of the beads and document the evaluation.

We tested a variety of automatic shut-off switches and control systems for our test blown-in shutter model. None of the switches or systems that relied on physical pressure from the beads functioned adequately, and that approach was abandoned. We reviewed several optical

control techniques but concluded that option to be too expensive to be practical. We then investigated using a timer and found this to be a reasonable solution.

The time required to fill a void is very consistent. Our 1.5 cu. ft. test chamber was timed for 5 separate fill-cycles, and the times ranged from 2 minutes 41 seconds to 2 minutes 45 seconds. The variation of just +/- 1.2% indicates the run-time is very reliable and a practical means for control. Additionally, extra run-time on the blower has no significant effect on any of the components, and only utilizes a small amount of electricity. Consequently, the timer can be set for a modest over-run time, and then can be easily adjusted if need be. We have yet to determine if seasonal temperature and/or humidity variations will have a significant effect on fill times, but the components allow this to be accommodated without difficulty if necessary.

We have procured some Crydom timed relays which are adjustable from 1 second to 100 hours. These will obviously provide the range needed to adjust to any sized shutter we could realistically imagine. As soon as we have installed and tested this system, we will be ready for the final approval of the complete blown-in shutter design.

Task 3. Develop plans for testing box and project instrumentation; Arctic Sun's plans for the testing box were approved.

Task 4. Construct testing box; The box was constructed immediately north of our shop, in the sun shadow of our office building (photo below). This location is easily monitored and will essentially eliminate any solar gain influences on the box, and will also minimize wind load. A complete weather-station was installed on the northeast corner of the box, and the single window was installed in the north wall. Standard remote-wall construction techniques were utilized throughout the structure to approximate real-world dynamics. Twelve inches of expanded polystyrene was utilized on the top, bottom and all four sides of the structure.

Staff from ACEP inspected the box just before the last few sensors were connected to the data recording system. Two conduits run from the testing box to inside our shop, so all sensors can be monitored remotely without opening or entering the box.

The left photo below shows the inside of the box with several of the temperature sensors (three arrows), the circulation fan, and the 750-watt heater near the floor. The corner of the

window is just visible in the right edge of the photo. The photo on the right shows the ceiling access hatch, all four temperature sensors (arrows) and the thermostat.

Future Work: The near-term priority is for staff to complete the blown-in shutter design, and specifically the automated shut-off system. We will then finalize our proposal for the specific field test-site locations and procure the supplies needed to begin the test installations.

We will begin collecting baseline data from the testing box as soon as we complete the sensor connections. After an adequate baseline is established, we will install a rigid shutter for testing. Additional baseline data-collection will take place at intervals between the installation and testing of different shutters.

We do not foresee any significant problems with the next phases of the project.